grants being subject to the roads being kept in repair to the satisfaction of the county justices. A further improvement took place when these roads were taken over by the County Councils.

The bicycle has, however, been the main agent in recent road improvement. To use these machines with any comfort a road must be in thoroughly good order, level, and free from loose stones and mud. The voice of the bicyclist is heard everywhere calling out when roads are in bad order, and local legislators are driven both by their own experience and that of their constituents to bring about a better condition of the main roads and highways. An institution known as the Roads Improvement Association has been formed, and, besides bringing pressure to bear on the local authorities, has issued a great quantity of literature for the guidance of local surveyors and roadmen as to the management of the roads; upwards of 13,000 pamphlets containing practical information on the management of roads have been distributed by this society.

Fortunately road reformers are able to show, by conclusive evidence, that roads kept in thoroughly good order cost less in annual maintenance than when they are left to get rutty and uneven and covered with mud or loose stones.

Mr. Aitken's book is a good practical treatise on the making and maintenance of roads. It is divided into fifteen chapters, which deal respectively with the history of road-making; traction; the construction of new roads; bridges, culverts and retaining walls; road material; quarrying; stone-breaking and haulage; road-rolling and scarifying; paved roads, including wood, asphalt, brick, and tar macadam; footways, &c.

The book deals principally with main roads and those subject to heavy traffic, which, as a rule, are now under the care of the county surveyors, who are skilled experts, and very little attention has been given to the requirements of the ordinary highways, where improvement is most required. The space devoted to quarrying, which occupies no less than sixty-seven pages, or about one-sixth of the whole book, could well have been spared, as it is rarely in these days that a surveyor has to quarry his own road material, and the space would have been better devoted to showing how ordinary highways may be maintained in good order and kept level and clean, and material placed on them when required without inconvenience to the traffic in situations where steam road-rolling is impracticable.

OUR BOOK SHELF.

Knowledge, Belief and Certitude. By F. Storrs Turner. Pp. viii + 484. (London: Swan Sonnenschein and Co., Ltd., 1900.) Price 7*s.* 6*d.* net.

MR. STORRS TURNER distinguishes knowledge from consciousness as interpretation from datum. He alleges as base of the former three certitudes, as to self, other selves and real things. He finds the sciences to involve the same pre-conditions and to take a permissibly abstract point of view—that of a fictitious independent spectator. But he holds that, therefore, the sciences are not adequate to concrete reality, while the pretension of science in general to present the whole is vain. In psychology the standpoint of the ideal spectator is inadmissible, and philosophy has failed because of the same abstraction. But among concrete ends we find our conviction as to some certain knowledge satisfied. Real knowledge belongs to the teleological sphere.

His conclusion to the failure of the speculative and the success of the purposive reason surprised Mr. Turner with the force of a revelation. The first chapters of his inquiry, which "remain substantially as they were originally written," were committed to paper years ago when "a dense fog" covered his mind. A trace of this is to be found in the attempt to maintain concurrently that the certitude of other selves is an inference of reason (p. 74), that it is plainly one with the certitude of self (p. 89), and that neither is able to come into existence apart from the other (p. 95). Mr. Turner can say within a page that "by real things we mean permanent things" (p. 80), and that "what we have is the certitude that there are a multitude of real things, some of them permanent, most of them changing" (p. 81). It will perhaps be unnecessary to say that his verbal criticism on such writers as Mr. F. H. Bradley depends for its validity on a hit or miss principle. It is a little grotesque to have estimates of Hegelian metaphysics and post-Hegelian logic from the standpoint of "reflective common-sense, aware of its limitations." Mr. Turner thinks that continuity implies indivisibility, and his verdicts on much in philosophy and science rest on similar misunderstandings.

"Knowledge, Belief and Certitude" is, however, by no means a worthless book. There is a certain dialectical ability in much of it, and a tenacity as to main principles which will appeal to the clear-headed reader who can discount the fallacious element. It is, however, as an honest attempt to think the problem of knowledge right through, and to present a record of the process as well as the results of his investigation, that it chiefly commends itself. How and why Mr. Turner came to his estimate of various views and systems, rather than that estimate itself, is the thing worth studying.

H. W. B.

Notions de Minéralogie. Par A. F. Renard et F. Stöber. II^me^ Fascicule; Classification et Description des Espèces Minérales. Pp. 191 to 374. (Gand: Ad Hoste, 1900.)

THE first fascicule of this text-book, containing the general principles of mineralogy, has already been noticed. The second fascicule (pp. 191–374) is devoted to the detailed description of mineral species. A large number of species are mentioned and, consequently, the majority are only briefly treated; in its main features the book necessarily resembles other mineralogical text-books.

It seems that, by a wise provision, all candidates in natural science at the University of Gand devote one hour weekly to the study of mineralogy, and it is for these students that the book is primarily intended. From this point of view we think that, as in most text-books, more species are mentioned than is necessary; such rare minerals, for example, as chalcomenite and nitrobarite should scarcely come within the range of the elementary student, but the brief descriptions of the commoner minerals leave nothing to be desired.

There are several useful features in the book which deserve special mention. In the case of most of the minerals of commercial importance, such as mica, apatite, cassiterite, galena and sulphur, a statement is given of the annual world's yield and its approximate value.

Another important feature is a summary of the minerals of Belgium with their localities, with which the volume concludes. Such local information is extremely useful, and this is the first authentic list of Belgian minerals and localities which has been given. The list has evidently been compiled with care; special attention is

directed to those minerals which are peculiar to Belgium.

Many of the figures will disappoint the modern reader on account of the indifferent printing; but among the illustrations he will find several useful diagrams which are not the familiar figures common to all the text-books, for example, the projection which shows the migration of the indicatrix axes with change of composition in the plagioclase felspars.

The authors have succeeded in producing within a small compass a fairly comprehensive yet lucid treatise on the principles of mineralogy and the chief mineral species, which may safely be recommended to the student in England as well as in Belgium.

The Essentials of Practical Bacteriology: an Elementary Laboratory Book for Students and Practitioners. By H. J. Curtis, B.S. and M.D. Lond., F.R.C.S. (London: Longmans, Green and Co., 1900.)

THIS book consists of a series of lessons upon practical bacteriology, mainly for a course of study required for the Diploma of Public Health. Commencing with the preparation of nutrient media, it passes on to the systematic study of, first, certain typical non-pathogenic bacteria, then to the moulds, including ringworm and allied forms, the account of which is much fuller than usual, and, lastly, to the pathogenic organisms. Fermentation and the beer yeasts are referred to, the malaria parasites, the *Amoeba coli*, and the supposed cancer organisms are described, and the methods employed for the examination of air, water, &c., and for testing disinfectants are given. The practical details described seem to be fairly complete and accurate, and the book is copiously illustrated, many of the illustrations of cultures being extremely good. The *Bacillus enteritidis sporogenes* of Klein is not mentioned, though it is a capital organism for class work. The method of freeing cultures for the "Widal" reaction from clumps by filtration is attributed to Symmers, but is mentioned in Hewlett's "Manual of Bacteriology." The paraffin method of embedding described is needlessly complicated. These and a few other omissions and errors will doubtless be corrected should another edition be called for.

What is Heat? and What is Electricity? By F. Hovenden. Pp. xvi + 329. (London: Chapman and Hall, Ltd., 1900.)

MR. HOVENDEN has set himself the modest task of overthrowing, in the space of about 300 pages, all existing physical tenets, and substituting in their place a remarkable theory of his own. In this effort he has not succeeded, except, apparently, to his own complete satisfaction. In the first part of the book the author quotes freely from Maxwell and others, and endeavours to prove that their reasoning is fallacious. His arguments only show that he does not understand what he quotes, and that he has not appreciated the most elementary principles of the subject, such, for example, as the difference between mass and weight. Having, as he considers, sufficiently disposed of the views held by modern men of science, Mr. Hovenden proceeds to the elucidation of his own theory. It is impossible to regard this part of the book seriously, Mr. Hovenden's deductions from experiments being altogether too extravagantly absurd. It is interesting to note that his treatment of the subject is throughout entirely qualitative; we venture to think that in no single instance would Mr. Hovenden's explanations stand the test of quantitative examination. If modern theory is to be disproved, it will not be by such writings as this. The least one can expect of its opponents is that they should properly understand the fundamental conceptions involved, and this Mr. Hovenden cannot be said to have attempted to do.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

On a Proof of Traction-Elasticity of Liquids.

I HAVE read with much interest the note of Mr. T. J. Baker, on a surface-tension experiment (NATURE, No. 1600, June 28, 1900). The author describes, with photographic illustrations, a phenomenon at first observed by Savart (1833), and later studied by Hagen, Tyndall, J. Plateau, Boussinesq and myself, but in all these studies, as in Mr. Baker's note, no other force than surface tension is supposed to produce the different phases of the phenomenon. Therefore I resumed the subject two years ago [1] and endeavoured to explain the consecutive phases by proving that in this experiment there arises always some elasticity of traction, not only in both superficial layers, but even in the whole mass of the sheet.

For example, if the velocity of the jet is extremely high, the liquid is suddenly compressed by the shock against the disc; but on account of the perfect elasticity of the liquid, there is no sensible loss of *vis viva*, and the little expansion is performed in a very minute fraction of a second, during which the liquid is quickly projected in all directions parallel with the plane of the disc, and forms a sheet; as long as the intermolecular distances do not increase, the only retarding forces are the surface-tensions of both faces of the sheet; therefore the central part of the latter is even and transparent. But soon, by the stretching-out of the sheet, all molecules separate from each other, extremely little indeed, but enough to produce suddenly strong resistances; then each coming layer strikes against a retarded one, and so are formed circular strips from which many drops constantly part. Besides, as the elasticity cannot be the same in all points of a circular strip, some radial strips are also produced in the sheet, from whose broken edge very many little drops are continually thrown.

On diminishing the rate of outflow, the production of interior elasticity of traction becomes also smaller, and therefore the transparent portion of the sheet increases gradually; but the edge sinks slowly, and soon closes inwards and reaches the vertical piece supporting the disc. The surface-tension of both faces of the sheet is not the only force which drags in the water radially; for by the action of gravity the sheet can be compared with a membrane of india-rubber, that is to say, all portions are distended, not only in the superficial layers, but even in the interior mass.

It is easy to show that the distension of falling particles is all the greater as the velocity is smaller. Therefore the elasticity of traction produced by gravity increases in the proportion that the movement slackens.

We can now understand why the motion of the liquid in the vicinity of the summit of the closed figure becomes more and more difficult, until the figure rises above the plane of the disc, afterwards falls again and reforms a closed figure of smaller breadth.

With a still slower stream of water, the figure begins to oscillate vertically, just because the force of gravity draws it down, while the elastic force of traction pulls it up.

Ghent, January 2. G. VAN DER MENSBRUGGHE.

Mathematics and Biology.

IN the interesting address of Prof. Howes published in NATURE of December 10 occur the following words:—

"On this basis there are now being pushed forward attempts to apply statistical, experimental and mathematical tests to the study of vital phenomena. All honour to those who are making them, for it is certain there are phases of life capable of mathematical treatment, but the mystery of life can never be thus solved; and, concerning the objection to the observational method, with confirmation and generalisation, and rejection of the non-confirmable, our non-mathematical procedure is scientific. Huxley has long ago said of mathematics that what you get out of the machine depends entirely upon what you put into it."

[1] "*Sur les nombreux effets de l'élasticité des liquides*," 3me Communication (*Bull. de l'Acad. Roy. de Belgique*, 3me série, vol. xxxvi., p. 281, 1898.)